

PATENT

Attorney Docket No.: AMAT/7532/CPI/L/B/PJS

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What is claimed is:

1. A method for forming a cap layer, comprising:  
depositing a barrier layer in a feature in a dielectric layer of a substrate;  
filling the feature with a metal-containing layer;  
planarizing the substrate; and  
depositing a cap layer on the substrate by a cyclical deposition process.
2. The method of claim 1, wherein the cyclical deposition process comprises alternately pulsing a metal-containing compound and a nitrogen-containing compound to deposit the cap layer, wherein the cap layer is a refractory metal nitride layer.
3. The method of claim 2, wherein the refractory metal layer comprises tantalum nitride.
4. The method of claim 2, wherein the pulsing is continued until the refractory metal nitride layer has a crystalline like structure over the metal-containing layer.
5. The method of claim 2, wherein the pulsing occurs at a pressure between about 0.5 Torr and about 5 Torr at a temperature between about 150°C and about 350°C.
6. The method of claim 2, wherein each pulse is repeated until the cap layer has a thickness of about 10 angstroms.
7. The method of claim 2, wherein each pulse is repeated until the cap layer has a thickness of from about 5 angstroms to about 20 angstroms.

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8. The method of claim 2, further comprising flowing a non-reactive gas continuously during each pulse of the metal-containing compound and each pulse of the nitrogen-containing compound.
9. The method of claim 2, wherein each pulse of the metal-containing compound and the nitrogen-containing compound is separated by a time delay.
10. The method of claim 1, wherein the cap layer has a thickness sufficient to block diffusion of metal atoms from the metal-containing layer.
11. The method of claim 1, further comprising depositing an etch stop layer on the cap layer.
12. A method for processing a substrate, comprising:
  - depositing a barrier layer in a feature in a dielectric layer of a substrate;
  - filling the feature with a metal-containing layer;
  - planarizing the substrate;
  - depositing a cap layer comprising tantalum nitride on the substrate by a cyclical deposition process; and
  - depositing an etch stop layer on the cap layer.
13. The method of claim 12, wherein the cyclical deposition process comprises alternately pulsing a metal-containing compound and a nitrogen-containing compound to deposit the cap layer.
14. The method of claim 13, wherein the pulsing is continued until the cap layer has a crystalline like structure over the metal-containing layer.
15. The method of claim 13, wherein each pulse is repeated until the cap layer has a thickness of from about 5 angstroms to about 20 angstroms.

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16. The method of claim 13, further comprising flowing a non-reactive gas continuously during each pulse of the metal-containing compound and each pulse of the nitrogen-containing compound.

17. The method of claim 13, wherein each pulse of the metal-containing compound and the nitrogen-containing compound is separated by a time delay.

18. The method of claim 12, wherein the cap layer has a thickness sufficient to block diffusion of metal atoms from the metal-containing layer.

19. A method of forming a dual damascene structure, comprising:  
depositing a first dielectric film on a substrate;  
depositing an etch stop on the first dielectric film;  
pattern etching the etch stop to define a vertical interconnect opening and expose the first dielectric film;  
depositing a second dielectric film on the etch stop and the exposed first dielectric film;  
pattern etching the second dielectric film to define a horizontal interconnect and continuing to etch the exposed first dielectric film to define the vertical interconnect;  
depositing a barrier layer on the substrate;  
depositing a metal-containing layer on the substrate to fill the vertical interconnect and the horizontal interconnect;  
planarizing the substrate;  
depositing a cap layer on the substrate by a cyclical deposition process; and  
depositing an etch stop layer on the cap layer.

20. The method of claim 19, wherein the cyclical deposition process comprises alternately pulsing a metal-containing compound and a nitrogen-containing compound to deposit the cap layer, wherein the cap layer is a refractory metal nitride layer.

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21. The method of claim 20, wherein the refractory metal layer comprises tantalum nitride.
22. The method of claim 20, wherein the pulsing is continued until the refractory metal nitride layer has a crystalline like structure over the metal-containing layer.
23. The method of claim 20, wherein each pulse is repeated until the cap layer has a thickness of from about 5 angstroms to about 20 angstroms.
24. The method of claim 20, further comprising flowing a non-reactive gas continuously during each pulse of the metal-containing compound and each pulse of the nitrogen-containing compound.
25. The method of claim 20, wherein each pulse of the metal-containing compound and the nitrogen-containing compound is separated by a time delay.
26. The method of claim 19, wherein the cap layer has a thickness sufficient to block diffusion of metal atoms from the metal-containing layer.